Egg Processing, Cartoning and Transportation Costs: 2021 Update

6/17/2022

Compiled by

Maro Ibarburu[1], Alejandro Plastina[2], Richard Gates[1] and Lesa Vold[1]

[1]Egg Industry Center
Iowa State University

[2] Department of Economics
Iowa State University

Executive Summary

The U.S. egg production industry runs on small profit margins. As a result, understanding each input cost is important to the decisions egg farmers make each day. Processing, Cartoning, and Transportation (PCT) costs are key components associated with delivering eggs to a store.

Previously, the Egg Industry Center published a special report estimating the PCT costs for 2020. This report updates the previous costs of processing eggs for the shell-egg market in 2021 and outlines the process and methodology for how results were generated.

Key findings include:

- Most costs are higher than those estimated in the previous report for 2020.
- The largest difference with respect to the previous study is in the processing cost.
- The cost of transporting eggs 400 miles estimated using this survey's data is very similar to the cost estimated for the same distance using the USDA's refrigerated truck rates.
- Cost line items with higher variability among the survey respondents are probably where processors have opportunities to reduce costs.

For this update, 18 responses were received representing approximately 74 million egg laying hens in the U.S. The survey responses allowed for updates to the costs of processing Gradeable Nest Run Class-1 (GNR1) eggs, but there was insufficient information to update the costs of processing graded loose eggs.

This report includes a section comparing the 2021 results with the 2020 results (Ibarburu et al., 2021). It is the intention of the Egg Industry Center to continue updating these cost estimates on a regular basis to assist the egg industry benchmark its financial costs.

Survey Questionnaire

A survey of U.S. egg processors was conducted to estimate costs associated with washing, weighing, packaging, and transporting eggs. The survey was based on a previous one created by the Egg Industry Center but modified after discussions with egg farmers to ensure that the questions could be answered with readily available farm information.

The survey contained seven questions, some of which had multiple subsections. These questions elicited information on the cost of packaging materials, processing (washing, weighing, packaging), and other relevant factors which influence costs.

The survey included questions for egg type, packaging type, case type, and miscellaneous.

There were three different types of eggs included in the survey:

- Gradeable Nest Run Class-1 (GNR1) sourced in-line,
- Gradeable Nest Run Class-1 (GNR1) sourced off-line, and
- Graded Loose large.

In-line sourced eggs are processed on the farm where they are produced. Off-line sourced eggs are eggs that are trucked from the farm to a different facility for processing. Processing refers to cleaning, quality control checks, grading, packaging, and refrigerating.

For each egg type, the percentage of eggs of different sizes and classes were surveyed and then used to estimate the associated grade yield loss or gain.

Four different packaging types options were provided in the survey:

- 12-pack carton,
- 18-pack carton,
- 5-dozen packs, and
- filler flats.

Two types of cases were considered:

- regular corrugated cardboard case and
- reusable plastic containers.

The corrugated cardboard case costs were further separated by 30-dozen and 15-dozen cases.

The survey also included three questions related to:

- finishing costs for putting boxes of eggs in pallets, wrapping them, etc.
- losses from store returns, and
- differences in costs between USDA-graded eggs and non-USDA-graded eggs.

The entire survey questionnaire is reproduced in this report as Appendix 1.

Anonymous Data Collection

In January 2022, the survey was sent to more than 100 egg producer/processor companies for which the Egg Industry Center had contact information. One person per company was chosen to receive the survey to avoid the possibility of duplicate responses. Participants were offered a variety of ways to return their surveys, all of which ensured that their identity was not traceable, therefore guaranteeing anonymity of the respondents and their companies.

The survey specifically asked for responses based on the PCT costs for the year 2021. Data collection was finished by April 2022.

Method of Analysis

The analysis was conducted in three stages, each of which is described in detail below. Briefly, outliers (extremely high or low values) were flagged and discarded prior to analysis. Then, two alternative measures of central location (a trimmed mean and the median) and the data dispersion (i.e., the interquartile range, IQR) were calculated. Finally, for responses with substantial scattering in their distribution, cluster analyses were conducted to identify groups within the distribution with high degrees of similarity within each group but with significant differences among groups. This step was conducted to understand whether a unique cost estimate could reasonably characterize all responses, or whether other influencing factors should be included.

Outliers

Outliers were identified using Tukey's method (1977) which consists of the following steps:

- Compute the interquartile range (IQR), i.e., the difference between the values of the 75th and 25th percentiles
- Multiply that difference by 1.5, or 1.5IQR
- Identify and discard any values less than the 25th percentile minus 1.5 x IQR, or greater than the 75th percentile plus 1.5 x IQR

Central Location

The most used measure of central location for a distribution of numerical values is the arithmetic mean, also called the simple average (i.e., the sum of the values across all responses divided by the count of responses). The average can be sensitive to bias when computed from data having asymmetric high or low values (i.e., a skewed distribution), even after removing outliers. Some survey response data presented extreme values and some of the distributions were skewed, thus two alternative measures of central location were used instead. These are the median and the trimmed mean, both of which are more robust to the presence of extreme values in skewed distributions. The trimmed mean in this report is the arithmetic mean after eliminating the top 20% and the bottom 20% of the observations. The outliers were eliminated before estimating the median, the trimmed mean, and the 25th and 75th percentiles.

The median is a robust central measure (Rice, 2006), but one of its key disadvantages is that it ignores the values outside the center, and such information might be valuable. An advantage of the trimmed mean over the median is that it incorporates information not only from the center of the distribution, but also from the 60% of the sample that was left after eliminating the top 20% and the bottom 20% of the observations.

Both median and trimmed mean have advantages and disadvantages but in general there is no best central measure for all skewed distributions and utilizing two measures is preferred by some (Rice, 2006) whereas the median is considered most appropriate by others (Snedecor and Cochran, 1989).

Dispersion of Responses

While the standard deviation is commonly used to represent the dispersion of data about a central location, in this study the single measure of dispersion is the IQR because it represents the dispersion around the median.

Clustering Analysis

Hierarchical clustering analysis was conducted to identify groups of responses with similar values within each cost category.

Definitions and detailed information regarding the median, percentiles, trimmed mean and clustering analysis are fully described in the 2018 study report (Ibarburu et al., 2019).

Survey Results

A total of 18 responses were received, compared to 16 in the previous analysis. Although it is impossible to know the production of the laying hens represented by the responses due to the anonymity of the respondents, some estimates suggest this represents approximately 74 million layers. The assumptions used for that estimation were derived from the February 2021 edition of magazine *Egg-*

Industry, published by WATT Media. This publication shares data about egg company rankings and helped provide the foundational data for the following assumptions:

- Farmers that process more than three million cases in a year would have on average 10.7 million layers,
- Farmers that process less than three million cases would have on average 1.6 million layers.

Under these assumptions, the survey responses represent approximately 23% of the U.S. laying hen inventory, and 33% of the laying hens dedicated to shell egg production.

It was estimated that approximately 85% percent of the eggs processed by the respondents were nest-run in-line eggs, 11% were nest-run off-line eggs, and 4% were graded loose eggs. If a respondent indicated they didn't process any of the four egg types listed above, their responses related to those eggs were not included in the analysis.

Packaging costs:

Table 1 presents the survey results for the various types of packaging materials and their associated costs. The total number of usable responses is shown as well as the calculated median and trimmed mean costs, the dispersion, and the difference between the median and the trimmed mean expressed in both cents per dozen eggs and in percent.

Table 1. Packaging material for cartoned eggs in cents per dozen

	Usable responses	Trimmed mean	Percentiles				Difference*	
			Median	25th	75th	IQR	cents/doz.	%
Carton cost: 12 - Pack	14	11.01	11.00	10.45	11.58	1.13	-0.01	0%
Carton cost: 18 - pack	13	10.35	10.20	10.00	11.00	1.00	-0.15	-2%
Other packaging: "5 dozen"	11	12.89	13.04	11.00	15.00	4.00	0.15	1%
Other packaging: "filler flats"	14	3.34	3.40	3.01	3.60	0.59	0.06	2%
Case cost (30 dozen)	13	4.18	4.06	4.00	4.60	0.60	-0.11	-3%
Case cost (15 dozen)	15	4.60	4.60	4.14	5.00	0.86	0.00	0%
Finishing costs:	14	1.50	1.43	1.20	2.00	0.80	-0.08	-5%

* Difference is the difference between the median and the trimmed mean estimates

There were 14 usable responses for the 12-egg carton cost. The median cost of the 12-egg carton was 11.00 cents/dozen and the trimmed mean was 11.01 cents/dozen. The dispersion around the median is small both as expressed in cents/dozen (1.13) and as a percentage of the median (10%).

There were 13 usable responses for the 18-egg carton cost. The median cost of the 18-egg carton was 10.20 cents/dozen and the trimmed mean was 10.35 cents/dozen. The dispersion around the median is small both as expressed in cents/dozen (1.00) and as a percentage of the median (10%).

There were 11 usable responses for the 5-dozen package cost. The data were organized into two distinct clusters ($p<0.05$): the 1st cluster consisted of three observations with a median value of 9.90 cents/dozen, and the 2nd cluster consisted of eight observations with a median value of 13.60 cents/dozen. The overall median and trimmed mean were 13.04 and 12.89 cents/dozen, respectively. The dispersion around the median is medium both as expressed in cents/dozen (4.00) and as a percentage of the median (31%). The

clustering of the data and the fact that the median number is higher than the cost of a 1-dozen package cast some uncertainty about the accuracy of these estimates.

There were 14 usable responses for the filler flats cost. The median cost of the filler flats was 3.40 cents/dozen and the trimmed mean was 3.34 cents/dozen. The dispersion around the median is small both as expressed in cents/dozen (0.59) and as a percentage of the median (17%).

There were 13 usable responses for the case cost for a 30-dozen case. The median case cost was 4.06 cents/dozen and the trimmed mean was 4.18 cents/dozen (a 3% difference between these two estimates). The dispersion around the median is small both as expressed in cents/dozen (0.60) and as a percentage of the median (15%).

There were 15 usable responses for the case cost for a 15-dozen case. The median case cost was 4.60 cents/dozen and the trimmed mean was 4.60 cents/dozen. The dispersion around the median is small both as expressed in cents/dozen (0.86) and as a percentage of the median (19%).

There were 14 usable responses for the finishing cost (pallets, shrink wrap, slip sheets, etc.). The data were organized into two distinct clusters ($p<0.05$): the 1st cluster consisted of nine observations with a median value of 1.21 cents/dozen, and the 2nd cluster consisted of seven observations with a median value of 2.00 cents/dozen. The overall median and trimmed mean were 1.43 and 1.50 cents/dozen, respectively, but the clustering of the data cast some uncertainty about the accuracy of these estimates. The dispersion around the median is small expressed in cents/dozen (0.80), but it is large when expressed as a percentage of the median (56%).

There were only six usable responses for the reusable plastic containers cost. Therefore, the results are not reported.

Processing costs:

The processing costs are divided into two components, the cost of processing (washing, weighing, etc.) and the grade yield loss (which is the sum of the losses for eggs received that are of lower value such as smaller sizes, or undergrades, and the gain for the eggs received that are of higher value such as larger size eggs).

Table 2 presents the results for the processing cost of Graded Nest Run Eggs – Class 1 (GNR1 eggs), sourced in-line and sourced off-line. The total number of usable responses per cluster is shown as well as the calculated median for the different clusters of data.

Table 2. Cost of processing Gradeable Nest Run Class-1 eggs (cents per dozen)

Eggs sourced	Usable responses	Trimmed mean	Median	Measure of dispersion
IN-line (cluster 1)	10		12.00	Difference between the: maximum of cluster 1 and the minimum of cluster 2 = 4.50
IN-line (cluster 2)	4		29.00	
OFF-line (cluster 1)	4		16.75	Difference between the: maximum of cluster 1 and the minimum of cluster 2 = 7.00
OFF-line (cluster 2)	5		34.00	

There were 14 usable responses for the cost of processing GNR1 eggs sourced in-line. The data were organized into two distinct clusters ($p<0.05$): the 1st cluster consisted of 10 observations with a median value of 12.00 cents/dozen, and the 2nd cluster consisted of four observations with a median value of 29.00 cents/dozen. To illustrate the jump between these two clusters, the difference between the maximum value of cluster one and the minimum value of cluster two was 4.50 cents/dozen. The overall median and trimmed mean were 17.15 and 17.07 cents/dozen, respectively, but the clustering of the data cast some uncertainty about the accuracy of these estimates. The dispersion around the median is very large as expressed in cents/dozen (12.52) and large expressed as a percentage of the median (73%).

There were nine usable responses for the cost of processing GNR1 eggs sourced off-line. The data were organized into two distinct clusters ($p<0.05$): the 1st cluster consisted of four observations with a median value of 16.75 cents/dozen, and the 2nd cluster consisted of five observations with a median value of 34.00 cents/dozen. To illustrate the jump between these two clusters, the difference between the maximum value of cluster one and the minimum value of cluster two was 7.00 cents/dozen.

There were only five responses for the cost of processing graded loose eggs and the responses were very different between them. Therefore, the results are not reported.

In order to estimate the grade yield loss, this survey asked for proportions of different egg sizes and classes obtained when the egg farmers process GNR1 eggs and graded loose eggs. To avoid skewing the results with outlier values, the proportions were estimated in three steps. The first step was to estimate the median value for the proportion of eggs in each size category. The second step was to calculate the sum of the median values. Finally, the share of each size category with respect to the sum of median values was defined as the estimated percentage of eggs by size so that the estimated proportions add up to 100%. The results are shown in Table 3. These proportions of eggs of different classes and sizes were then used to estimate the grade yield loss published in Table 4. There were only six answers for the gradeable nest run eggs sourced off-line and four answers for the graded loose eggs. Therefore, the results are not reported.

Table 3. Percentage of eggs of different sizes and classes for processing Gradeable Nest Run (GNR)

Eggs sourced	Usable responses	Percentage of eggs of different sizes and class						
		Jumbo	Extra-Large	Large	Medium	Small	Undergrades	Loss
GNR In-line	16	4.1%	26.0%	52.0%	10.0%	1.0%	5.0%	2.0%

The grade yield loss associated with processing GNR1 sourced in-line was estimated using the 2021 prices of white eggs of different sizes and classes for each region. The prices reported by USDA for eggs delivered to warehouses were used for: extra-large, large, and medium sizes (all white). USDA doesn't report warehouse prices for small or jumbo size eggs. Therefore, prices for jumbo eggs were estimated based on the price difference between jumbo and extra-large sizes of eggs as reported by Urner Barry for 2021, the estimated prices for jumbo eggs were between 16 and 24 cents/dozen higher than the extra-large egg prices, depending on the region. Similarly, the estimated prices for small eggs were between 22 and 26 cents/dozen lower than the medium egg prices based on the prices difference between these two sizes of eggs as reported by Urner Barry for 2021. The prices used for California are "eggs delivered to 1st recipients" as published by USDA. USDA doesn't report warehouse prices for the Northwest region; as a result, this was estimated as 16 cents/dozen higher than the Midwest region

prices based on the price difference between these two regions as reported by Urner Barry for 2021. The estimated grade yield loss is different between regions with the lowest estimated values in the Midwest, Northeast and South Central, and the highest values are in California, as shown in Table 4. There is also a large amount of variability by company in reported proportions of classes and sizes of eggs, this variability is not reflected in Tables 3 or 4.

Table 4. Estimated grade yield loss from processing Gradeable Nest Run class 1 eggs (GNR1)

	Estimated Grade Yield Loss using USDA prices for each region (cents/dozen)					
Eggs sourced	MW	NE	SE	SC	NW	CA
GNR1 in-line	6.16	5.84	7.95	6.10	7.28	9.80

A grade yield loss was estimated for each company using the company's reported proportion of eggs in different classes and sizes, and the prices of different egg types in the region where each company was operating. If a company had facilities in more than one region, a simple average of the egg prices across those regions was used. The median estimated grade yield loss from processing gradeable nest run eggs source in-line was 6.80 cents/dozen and the trimmed mean was 7.15 cents/dozen (Table 5). The dispersion around the median is medium expressed in cents/dozen (4.99), but it is large expressed as a percentage of the median (73%). There were not enough answers for GNR1 eggs sourced off-line and graded loose eggs to be able to report this detailed information.

Table 5. Estimated grade yield loss from processing Gradeable Nest Run Class-1 eggs using respondent region and percentages of eggs of different classes and sizes obtained

	Usable	Trimmed mean	Percentiles (cents/dozen)				Difference*	
Eggs sourced	responses	(cents/dozen)	Median	25th	75th	IQR	cents/doz.	%
GNR1 in-line	16	7.15	6.80	4.61	9.60	4.99	-0.35	-5%

* Difference is the difference between the median and the trimmed mean estimates

Transportation costs:

Table 6 presents the survey results for three types of transportation and associated costs. The total number of usable responses is shown as well as the calculated median and trimmed mean costs, the dispersion represented by the IQR (i.e., the difference between the 25th percentile and 75th percentile in the table), and the difference between the median and the trimmed mean expressed in both cents per dozen eggs and in percent.

Table 6. Transportation costs of cartoned eggs in cents per dozen (for freight within the same U.S. region):

	Usable	Trimmed	Percentiles				Difference*	
	responses	mean	Median	25th	75th	IQR	cents/doz.	%
Delivered - Store Door	8	12.00	12.00	10.75	13.23	2.48	0.00	0%
Delivered to a Warehouse	14	6.32	6.59	4.56	8.00	3.44	0.28	4%
Picked Up by a Warehouse	10	1.24	1.00	0.61	2.00	1.39	-0.24	-21%
Trucking 400 miles	10	7.88	7.52	6.94	9.39	2.45	-0.36	-5%

* Difference is the difference between the median and the trimmed mean estimates

There were eight usable responses for the cost of delivering eggs to a store door. The median cost of delivering eggs to a store door was 12.00 cents/dozen and the trimmed mean was 12.00 cents/dozen. The dispersion around the median is medium expressed in cents/dozen (2.48), but it is small expressed as a percentage of the median (21%).

There were 14 usable responses for the cost of delivering eggs to a warehouse. The median cost of delivering eggs to a warehouse was 6.59 cents/dozen and the trimmed mean was 6.32 cents/dozen. The dispersion around the median is medium expressed in cents/dozen (3.44), but is large expressed as a percentage of the median (52%). There is some indication that some of the variability could be explained by regional differences and transportation distances, but unfortunately, not enough responses were received to be able to estimate costs by region.

There were 10 usable responses for the picked-up cost. The median picked-up cost was 1.00 cents/dozen and the trimmed mean was 1.24 cents/dozen. The dispersion around the median is small expressed in cents/dozen (1.39), but is very large expressed as a percentage of the median (139%).

There were 10 usable responses for the cost of delivering eggs to a location 400 miles away. The median cost of delivering eggs to a location 400 miles away was 7.52 cents/dozen and the trimmed mean was 7.88 cents/dozen. The dispersion around the median is medium both as expressed in cents/dozen (2.45) and as a percentage of the median (33%).

Additional costs statistics:
There were 14 responses for the difference in processing costs between standard and USDA certified graded eggs. The data were organized into two distinct clusters ($p<0.05$): the 1st cluster consisted of 10 observations with a median value of 1.07 cents/dozen, and the 2nd cluster consisted of four observations with a median value of 3.00 cents/dozen. The overall median and trimmed mean were 1.50 and 1.60 cents/dozen, respectively, but the clustering of the data cast some uncertainty about the accuracy of these estimates.

There were only six responses for the loss from store returns and the responses were very different. Therefore, the results are not reported.

Total PCT Costs (delivered to warehouses):
A total of 108 combinations are possible with the responses obtained through this survey. These include: egg types processed (two types included in the survey), packaging sizes (three types included in the survey), cases or reusable plastic containers (three options), transportation modes (three types included in the survey), and grading (USDA graded or not). These can potentially provide estimates of PCT costs for 108 combinations in each region, provided that enough responses were received. The example below (Table 7) shows the estimated PCT cost of gradeable nest run eggs sourced in-line, non-USDA certified graded eggs, packaged in 12-pack cartons in regular cases, and delivered to a warehouse.

Table 7. PCT costs for processing Gradeable Nest Run Class-1 eggs, packaged in 12-pack cartons, in regular cases, non-USDA certified, and delivered to a warehouse (loss from store returns not included)

Eggs sourced	Trimmed mean (cents/dozen)	Percentiles (cents/dozen)				Difference*	
		Median	25th	75th	IQR	cents/doz.	%
In-line	47.23	47.03	36.67	60.15	23.48	-1.22	-3%

* Difference is the difference between the median and the trimmed mean estimates

The median total PCT costs of eggs delivered to warehouses (calculated as the sum of the median cost of packaging, processing, and transportation to a warehouse within the same region) was 47.03 cents/dozen for GNR1 eggs sourced in-line (Table 7), and the trimmed mean was 47.23 cents/dozen. The difference between the trimmed mean and the median estimates was 3%. The loss from store returns wasn't included in this sum because of the concerns outlined on page 9, but they should be part of the calculation of total PCT costs. For USDA certified graded eggs, the cost difference between standard and USDA should be added. The dispersion around the median is very large expressed in cents/dozen (23.48), but it is medium when expressed as a percentage of the median (50%).

A main factor of the PCT cost is the grade yield loss calculation. This depends on the differences between the prices of eggs of different classes and sizes with respect to the price of grade A large white eggs. The prices of different classes and sizes of eggs are different between regions and change frequently. Therefore, this estimate is constantly changing throughout the entire year and varies between regions of the country as illustrated in Table 4.

Comparison with previous results

In this section, results from this survey's 2021 data are compared with the results from the previous survey using data from 2020.

Table 8 compares median, trimmed mean, and IQR for some of the costs. The 2021 median and trimmed mean values for the cost of the 12-egg carton were above the year 2020 75th percentile. The 2021 median and trimmed mean values for the cost of the 18-egg cartons were within the IQR obtained in 2020. The 2021 median and trimmed mean value for the cost of the 30-dozen cardboard cases were within the IQR obtained in 2020. The 2021 median and trimmed mean value for the cost of the 15-dozen cardboard cases were above the year 2020 75th percentile. The 2021 median value for the finishing costs was within the IQR obtained in 2020, while the 2021 trimmed mean values for the finishing costs was 0.02 cents/dozen higher than the 75th percentile values obtained in 2020.

Table 8. Comparison of costs between 2021 and 2020 survey data (cents per dozen)

	Results for 2021				Results for 2020			
	Trimmed mean	Median	25th Percentile	75th Percentile	Trimmed mean	Median	25th Percentile	75th Percentile
Carton cost: 12 - Pack	11.01	11.00	10.45	11.58	10.04	9.95	9.58	10.56
Carton cost: 18 - pack	10.35	10.20	10.00	11.00	10.36	9.95	9.14	12.02
Case cost (30 dozen)*	4.18	4.06	4.00	4.60	3.72	3.60	3.31	4.25
Case cost (15 dozen)*	4.60	4.60	4.14	5.00	4.07	4.10	3.82	4.26
Finishing costs:	1.50	1.43	1.20	2.00	1.13	1.14	0.78	1.48
Transportation Cost:								
Delivered to Warehouse	6.32	6.59	4.56	8.00	5.43	5.56	4.05	7.09
Picked up by Warehouse	1.24	1.00	0.61	2.00	1.12	1.14	0.35	1.85
Processing Cost for processing Gradeable Nest Run Class-1 eggs:								
Eggs Sourced In-line	17.07	17.15	11.85	24.37	14.21	12.90	12.47	17.18

The 2021 median and trimmed mean values for the cost of delivering eggs to a warehouse, and the cost of pick-up by warehouse option, were within their respective IQRs of 2020. However, the ranges were wide in both surveys.

The largest difference between the 2020 and 2021 studies is the cost of processing GNR1 eggs sourced in-line. The median and trimmed mean values for the cost of processing GNR1 eggs sourced in-line were within the IQR obtained in 2020. The ranges were very wide in both surveys.

Figure 1 compares the aggregate costs of packaging, processing, and transporting eggs to warehouses (excluding loss from store returns and grade yield loss) obtained in 2021 with the data from 2020, for GNR1 eggs sourced both in in-line. The median and trimmed mean values were within their respective IQRs of 2020 for both. But the ranges are very wide.

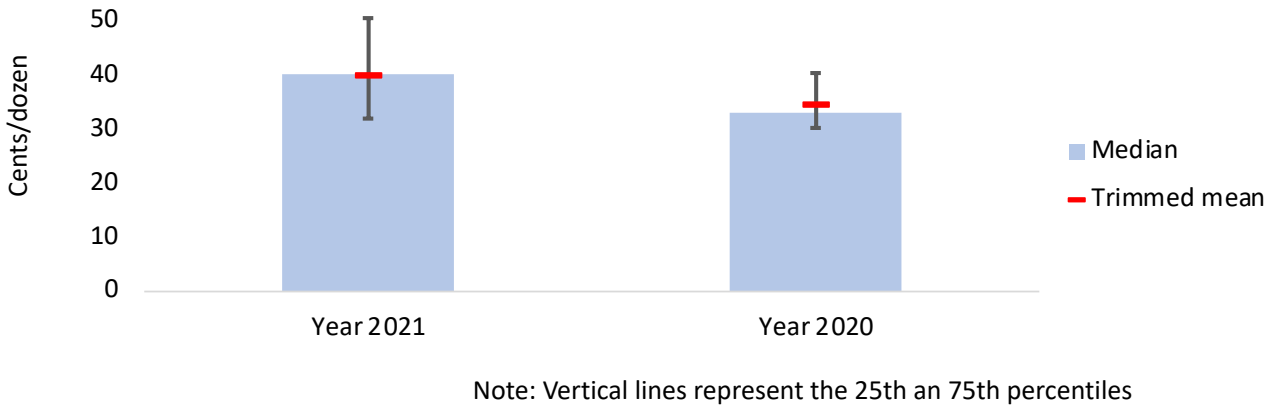

Figure 1. PCT costs of Gradeable Nest Run Class-1 eggs sourced in-line, packaged in 12-pack cartons in regular cases, non-USDA certified, and delivered to warehouses, without including the grade yield loss or loss from store returns.

Grade Yield Loss sensitivity to small changes in percentages

The estimated grade yield loss is not only sensitive to price changes but also depends on the proportions of eggs of different sizes obtained. To illustrate this point, the grade yield loss for different combinations of prices was estimated (year 2021 and 2022) and proportions (using proportions of different egg types reported in 2021 and using the weighted average of the proportions obtained in 2021 and 2022).

The proportions of the different egg types obtained from processing GNR1 eggs sourced in-line were very similar to that obtained in 2020 (Figure 2).

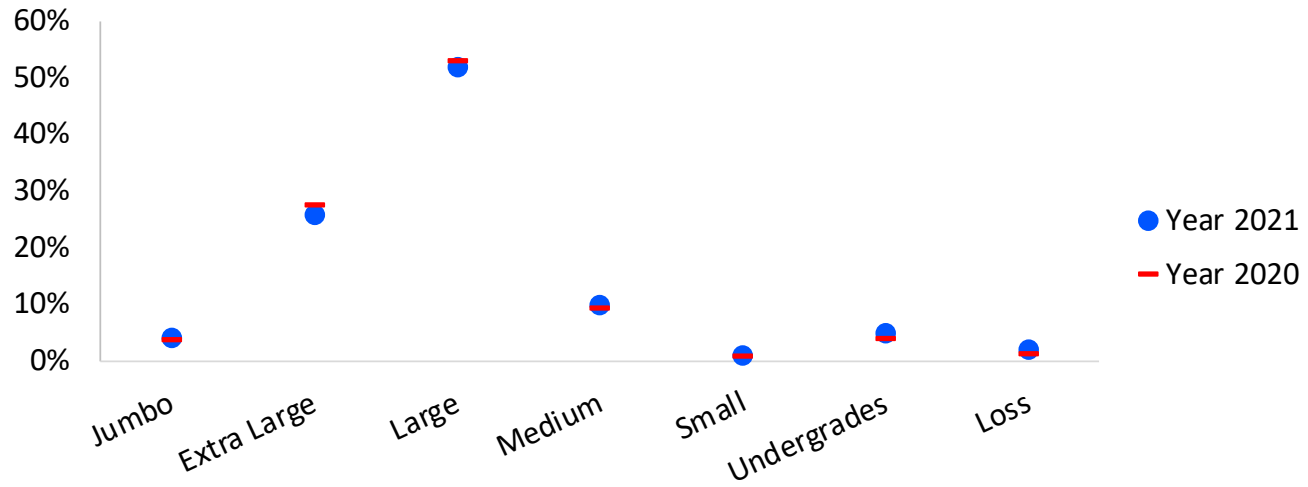

Figure 2. 2020 & 2021 comparison of proportions of the different egg types obtained from processing GNR1 eggs sourced in-line.

The grade yield loss associated with processing GNR1 eggs sourced in-line were estimated using the 2020 prices of white eggs of different sizes and classes for each region under two different proportions of different egg types: 1) the proportions obtained from the 2020 survey and 2) a weighted average of the proportions obtained from the 2020 survey and the 2021 survey (Table 9). The differences between these two estimates go from 0.81 cents/dozen in the Midwest to 1.56 cents/dozen in California. A similar comparison using 2021 prices resulted in differences between these two estimates from 0.57 cents/dozen in the Midwest to 1.03 cents/dozen in California.

Table 9. Estimated grade yield loss from processing Gradeable Nest Run class 1 eggs sourced in-line

Pricing year	Proportions of types of eggs used	Estimated Grade Yield Loss using USDA prices for each region (cents/dozen)					
		MW	NE	SE	SC	NW	CA
2020	year 2020	5.63	5.97	6.60	5.40	6.42	9.80
2020	2020-2021 Wtd. Avg.	6.43	6.86	7.53	6.41	7.39	11.36
2021	year 2021	6.16	5.84	7.95	6.10	7.28	9.80
2021	2020-2021 Wtd. Avg.	5.60	5.20	7.26	5.37	6.60	8.77

Transportation cost sensitivity to changes in distances

The transportation costs answers are normally very dispersed between different respondents and this variability is in part explained by the different transportation distances between farms and their customers. To illustrate how much the transportation cost depends on the distance, the values for different distances were estimated using USDA refrigerated truck rates. First, the rate per mile was plotted as a function of the distance for the shipments between 100 and 800 miles long, and a prediction curve was estimated in order to be able to estimate the expected average cost of transporting eggs over different distances (Figure 3). It is evident from the dispersion around the prediction curve that there are other factors (other than distance) affecting the rate as well.

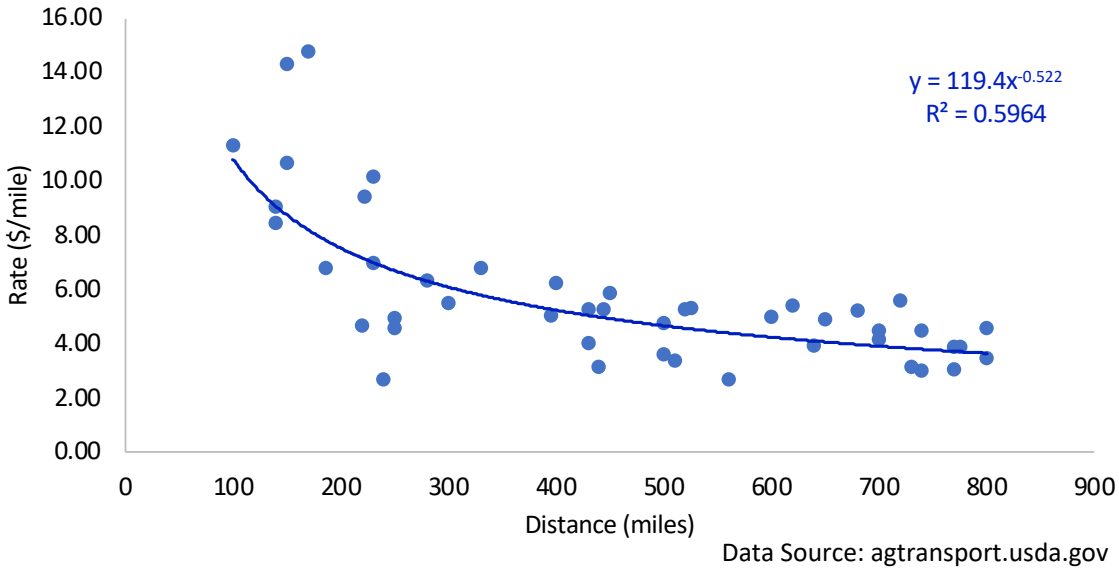

Figure 3: Estimates of refrigerated truck costs per mile for different trip distances, 2021 data.

Second, the prediction curve was used to estimate the cost of transporting eggs different distances, assuming 900 cases of eggs per truck (Table 10). It is worth noticing that the cost of transporting eggs 400 miles in 2021 falls within the estimated range from the present survey. Table 10 also shows the estimation for 2020 using the same procedure to illustrate how much transportation costs changed from 2020 to 2021.

Table 10. Estimated shell egg transportation cost by distance

Distance (miles)	Year 2021 average		Year 2020 average	
	Rate per mile	Cost/dozen	Rate per mile	Cost/dozen
200	7.51	5.57	6.31	4.68
300	6.08	6.76	5.05	5.61
400	5.23	7.75	4.31	6.38
500	4.66	8.62	3.81	7.06
600	4.23	9.41	3.45	7.66
700	3.91	10.13	3.17	8.21

Concluding Comments

This study documents 2021 processing, cartoning, and transportation cost estimates for the U.S. egg industry, with the objective to create a cost benchmarking tool. The findings presented in the previous sections are limited by the low number of responses obtained, which made regional cost estimates especially challenging.

The estimated median and trimmed mean PCT costs of processing GNR1 eggs sourced in-line and delivered to warehouses were 47.03 cents/dozen and 47.23 cents/dozen respectively, which are 22% and 18% respectively higher than the values obtained for 2020. The clustering of the data for some key variables and the wide dispersion around the median values cast some uncertainty about the accuracy of these estimates.

While some categories of reported costs are fairly concentrated around the median (e.g., 12-pack carton costs and case cost), other categories show high degrees of dispersion (e.g., processing cost and transportation). Consequently, any practical use of the estimates presented in this study must be qualified by the uncertainty surrounding the median and trimmed mean estimates.

In general, the results from this survey are mostly higher than the values obtained in 2020.

Also, it is evident that the price difference between different egg sizes in California result in a much greater grade yield loss than in the other regions.

The author's recommendation is that given the sensitivity of the grade yield loss to the proportions of different egg types and the low number of responses obtained, it might be a good idea to use the weighted average of consecutive years for estimating the grade yield loss by region. It will make the proportions more robust and the comparison between years will depend on price relationships more than on the changes in the proportions.

Acknowledgments

The authors thank Dr. Alicia Carriquiry, Iowa State University Distinguished Professor of the Department of Statistics, for her guidance about the best way to analyze this data. Also, a special thanks goes to the egg farmers/processors that collaborated with the study responding to the surveys.

References

Ibarburu, M., A. Plastina, and L. Vold. 2019. *Egg Processing, Cartoning and Transportation Costs: A Special Report*. Egg Industry Center, Iowa State University.

Ibarburu, M., A. Plastina, L. Vold and R. Gates. 2021. *Egg Processing, Cartoning and Transportation Costs: 2020 Update*. Egg Industry Center, Iowa State University.

Plastina, A., and A. Johanns. 2021. "Iowa Custom Rate Survey." Iowa State University Extension and Outreach, *Ag Decision Maker* File A3-10. Retrieved from: https://www.extension.iastate.edu/agdm/crops/pdf/a3-10.pdf

Rice, J. A. (2006). *Mathematical Statistics and Data Analysis 3rd edition.* Belmont, CA: Thompson Brooks/Cole

Snedecor, G. W.; Cochran, W. G. (1989). *Statistical Methods 8th edition*. Ames, IA: Iowa State University Press

Tukey, J.W. (1977). *Exploratory data analysis*. Reading, MA: Addison-Wesley Pub. Co.

USDA Refrigerated Truck Rates and Availability
https://agtransport.usda.gov/Truck/Refrigerated-Truck-Rates-and-Availability/acar-e3r8

Appendix 1. Survey Questionnaire

Egg Industry Center

Confidential
PROCESSING. CARTONING, and TRANSPORTATION (PC&T) SURVEY

Time period represented in this survey should be: January 2021 through December 2021

Please answer N/A on any question you don't have an answer for it.

Egg Industry Center

COMPANY CODE

This code is important to identify how much of the difference in future results is explained by actual changes in costs and how much is explained by the variation between companies filling the surveys in consecutive years.

Once a company code is generated/created, please store it for future use.

If you were not assigned a company code, please create your own. We suggest using: the 1st letter of your 1st pet name, the 2nd number of your home address, the 3rd letter of your mother maiden name, and a number between 0 and 9.

Companies can choose to fill one survey for the entire company or fill multiple surveys representing different locations as far as they avoid double counting locations.

OF EGGS REPRESENTED IN THIS SURVEY (mark with an "x" the one that applies)

More than 3 million cases ☐
Less than 3 million cases ☐

Question 1. NUMBER OF EGGS PROCESSED IN PLANT AS A % OF TOTAL

NEST RUN SOURCED IN-LINE	+	NEST RUN SOURCED OFF-LINE	+	GRADED LOOSE EGGS	=	TOTAL
						0.00

Question 2. PACKAGING MATERIAL FOR CARTONED EGGS

	(please specify units):	COST/UNIT	UNITS USED (select from drop down)
CARTON COST	12 - pack		cents/dozen
	18 - pack		cents/dozen
OTHER PACKAGING	5 dozen *		cents/dozen
	filler flats *		cents/dozen

* Please include additional materials and labor and pro-rata handling and freight if applicable

	COST/UNIT	UNITS USED (select from drop down)
CASE COST (30 dozen case):		cents/dozen
CASE COST (15 dozen case):		cents/dozen
Reusable Plastic Containers (Service fee and/or shrink + sanitation costs if owned):		cents/dozen
FINISHING COSTS (Pallets, Shrink Wrap, Slip Sheets, etc.):		cents/dozen

Question 3. PROCESSING COST: FOR EACH CATEGORY OF EGG PROCESSED, PLEASE INCLUDE THE SUM OF LABOR, BENEFITS, INTERNAL INSPECTIONS, FOOD SAFETY AUDITS + COMPLIANCE (SQF/HACCP), UTILITIES, MAINTENANCE, RENT, BUYING AND SELLING COSTS, ADMINISTRATIVE/FOOD SAFETY, BIOSECURITY AND WAREHOUSE (cents/dozen).

Costs should not include any marketing fee or discount given to the retailer for product placement or slotting.

For the food safety costs. Don't include the costs incurred in the layer houses such as testing and controlling rodent in the layer houses. These should be the costs associated with the egg processing only.

	PROCESSING COST (CENST/DOZEN)				
	Northeast	Southeast	Midwest	South Central	West
Gradeable Nest Run Class 1 - Sourced IN-LINE (GNR 1)					
Gradeable Nest Run Class 1 - Sourced OFF-LINE (GNR 1)					
Graded loose LG (plant grade)					

Appendix 1. Survey Questionnaire (continue)

Question 4. DATA TO ESTIMATE GRADE YIELD LOSS: FOR EACH CATEGORY OF EGG PROCESSED, PLEASE ANSWER WHICH PROPORTION OF THE DIFFERENT TYPES OF EGGS YOU END UP GETTING AFTER PROCESSING CONVENTIONALLY PRODUCED EGGS.

	GNR 1 - Sourced IN-LINE	GNR 1 - Sourced OFF-LINE	Graded loose LG (plant grade)
Percent of JUMBO			
Percent of EXTRA-LARGE			
Percent of LARGE			
Percent of MEDIUM			
Percent of SMALL			
Percent of UNDERGRADES ^			
Percent of LOSS			
TOTAL (sum must add to 100.00%)	0.00	0.00	0.00

^ sum of class B, pewes, and checks eggs

Question 5. TRANSPORTATION COSTS OF CARTONED EGGS (for freight WITHIN the same U.S. region):
INCLUDE FUEL, EQUIPMENT, ALL LABOR, ALL FEES, TOLLS
Please answer for all regions you know these costs.

		Northeast to Northeast	Southeast to Southeast	Midwest to Midwest	South Central to South Central	West to West
DELIVERED - STORE DOOR	CENTS/DOZEN					
	AVG. MILES/TRIP					
DELIVERED - WAREHOUSE	CENTS/DOZEN					
	AVG. MILES/TRIP					
PICKED UP - WAREHOUSE (only the cost of loading the truck)						
What was the cost of transporting eggs 400 MILES (CENTS/DOZEN)						

Note	all fees should include lumper fees for example
	all labor should include loading labor for example
	don't include customer allowance under picked-up costs because it might end up in double counting

Question 6. Loss from store returns:

Not applicable ☐

Percent of eggs that are returned from the store	
Average loss per dozen eggs returned (cents/dozen)	

Question 7. What's the processing cost difference between standard and top grade USDA certified?

COST Difference	UNITS USED (select from drop down)
	$/case

Note: Please include only USDA fee per case inspected. Don't include associated costs such as: stop production because of the plant is out of specification, diverted eggs because of wrong expiration date on a carton, etc.

Egg Industry Center